DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150600

DESIGN DATA BROCHURE FOR CSI SERIES V SOLAR HEATING SYSTEM

Prepared by

Contemporary Systems, Inc.
68 Charlonne Street
Jaffrey, New Hampshire 03452

Under Contract NAS8-32243 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

for the U. S. Department of Energy

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This work was done under the technical management of Mr. Valmore Fogle, George C. Marshall Space Flight Center.

16. ABSTRACT

This report contains the Design Data Brochure for Contemporary Systems Inc. (CSI), along with general information on system configuration, system sizing and mechanical layout. CSI is developing two single family prototype solar heating systems consisting of the following subsystems: collector, storage, control, transport, and government-furnished site data acquisition.

The systems are being installed at York,PA, and Manchester, NH.

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INTRODUCTION

DESIGN DATA BROCHURE

This Design Data Brochure has been prepared to assist the architect or designer in preparing construction drawings and specifications for the installation of the CSI Series V Integrated Solar Heating System.

It contains generalized information on system configuration, system sizing and mechanical layout. Few design constraints are imposed on the architectural style or construction methods. The availability of a full length collector, fabricated to the required job size, allows for greater efficiency in space utilization and less concern for leakage related to lateral seams in the roof assembly.

The importance of proper sizing of the collector array is discussed, and a preliminary estimating technique is presented. A more complete analysis, such as the SOLCOST service or CSI's own in-house computerized system sizing program, is recommended. Details of storage and transport subsystems are provided, with guidelines for specifying size and layout of each.

A full appendix is included which provides detailed drawings and specifications of all of the components of the CSI system, along with typical installation details. The entire system has been designed to facilitate quick installation, minimizing costly on-site labor. The installation techniques have been thoroughly field tested and are oriented toward the skills and capabilities of typical tradespersons, with no special knowledge required other than the information provided in the installation manual.

CONTENTS

GENERAL SYSTEM DESCRIPTION

The CSI integrated, warm air solar heating system eliminates most of the problems encountered by an architect or designer when incorporating solar heating in a construction project. The individual components are fully compatible and have been developed to work together.

The Series V collectors are structural units, fastened directly to the roof or wall framing members (24" o.c.). They form a fully weather-tight assembly which replaces the conventional roofing or siding. The collectors are manufactured in any length up to 24' to meet the design requirements of each installation. They are light weight -- less than two pounds per square foot -- and the insulation toward the living space is site-applied according to architectural specifications.

The Universal Switching Unit (USU) accomplishes the air circulating and switching functions. It can be equipped to operate at whatever CFM is dictated by the overall system design. Its main component is an industrial quality centrifugal fan with life lubricated ball bearings, operating at low RPM and powered by a high efficiency GE "Energy Saver" motor.

The control functions are performed by the completely automatic LCU-110 Logic Control Unit. It compares various system conditions and optimizes the use of solar energy while minimizing the use of the auxiliary heating system. The interior environment of a solar-heated house is in no way different from a conventionally heated one and requires no additional user-operated controls other than the standard room temperature thermostat. There is a manual override of the automatic functioning of the LCU Control Unit for servicing and special uses of the system.

The Fail-Safe Thermal Vents protect the collectors against overheating in summer or in the event of a power failure. They operate by thermosiphoning, and are generally connected to the inlet and outlet manifolds of the collector array.

SOLAR SYSTEM OPERATION

The system has six operating modes: standby, storing heat, heating from collectors, heating from storage, auxiliary heating, and combined auxiliary heating and storing heat (see Fig. 1). The order of priority is as follows:

1. Heating from collectors: when the room thermostat demands heat and the collectors are receiving sufficient energy to provide heated air at greater than approximately 85°F to the house.

2. Heating from storage: when the room thermostat demands heat and there is insufficient energy in the collectors but enough energy in storage to provide heated air at greater than about 85°F to the house.

3. Combined Auxiliary heating and storing heat: with heat demand and insufficient energy in collectors and storage for room heating but sufficient energy in the collectors to charge storage. In this case the auxiliary furnace provides for space heating and energy from the collectors is stored concurrently.

4. Auxiliary heating: when the house demands

OPERATING MODES :

A. STORING HEAT

B. HEATING FROM STORAGE

C. HEATING FROM COLLECTORS

D. AUXILIARY HEATING

TOLERANCES EXCEPT AS NOTED	TITLE: SYSTEM SCHEMATIC	
DECIMAL :	PROJECT GENERAL SPECIFICATIONS	
FUNCTIONAL :	PARALLEL SYSTEM	
ANGULAR :		
REVISIONS	DRAWN BY E.L.	CHECKED BY
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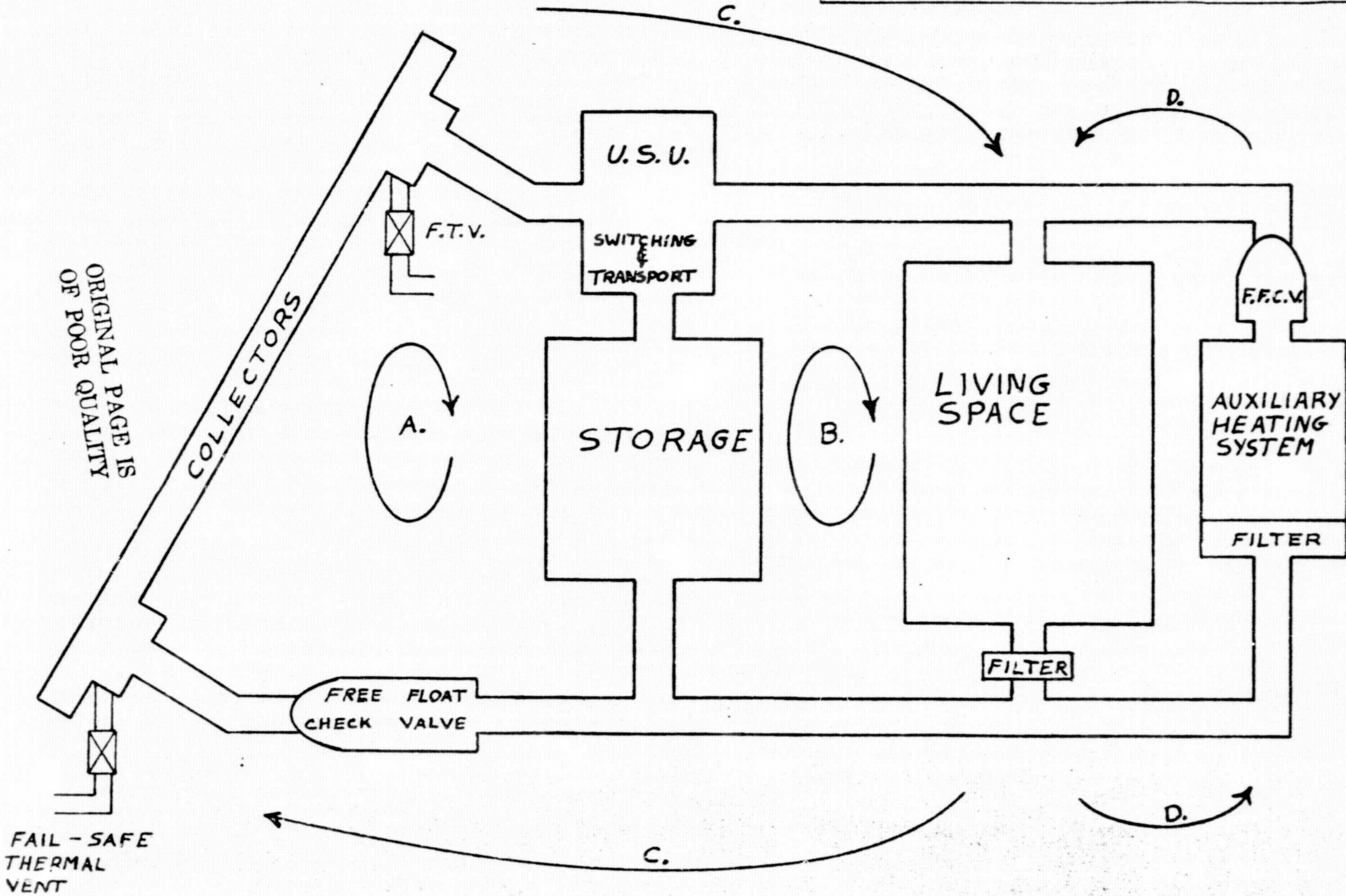

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heat and none is available from the collectors or from storage for space heating or storing. The auxiliary furnace provides back-up heating for the house.

5. Storing heat: with no heat demand from the house and sufficient energy in the collectors for storing.

6. Standby: with no heat demand and insufficient collector energy for storing (or a full storage).

The following points concerning system operation should also be noted:

1. In no mode is solar heat ever stored or used when its equivalent value, in auxiliary fuel dollars, would be less than the value of the electrical power needed to run the system.

2. The Fail-Safe Thermal Vents cool the collectors in warm weather when no heat is demanded or needed in storage. The collector array circulates outside air by thermosiphoning. The vents open automatically whenever coll. temp. exceeds 165°F, due either to ambient temperature rise or power failure.

3. The air flow through storage is reversed between storing and heating from storage modes so that temperature stratification is maintained.

4. The LCU-110 solar system control accomplishes automatic control of dampers, the USU, the auxiliary furnace and the fail-safe thermal vents. It monitors collector temperature, storage temperatures (hot end and cold end) and the two-stage room thermostat. Settable system parameters include: collector-storage differential and collector and storage output sensible heat temperatures. Storage temperature may also be limited, in summer, to 100°F.

5. Free float check valves are used in the system ducts where needed to prevent unwanted thermosiphoning and backflow through the auxiliary furnace.

6. A replaceable filter must be provided in the return duct from the living space to prevent dust accumulation in the rock storage or collectors. This system must be maintained with filters being replaced every 500 hours of operation.

GENERAL DESIGN CONSIDERATIONS

The general design of the house and its relation to the site have a very significant effect on the overall heating requirement, and consequently the percentage of solar sufficiency obtainable per square foot of collector area. CSI recommends as a minimum the energy-efficient construction standards known as the "Arkansas Plan." These standards are detailed in Owens-Corning's report on "Energy Saving Homes -- The Arkansas Story." The basic approach involves utilizing 2" x 6" studs, 24" o.c., with 6" of fiberglass insulation in the walls and 12" in the ceiling. There are specific recommendations for window area, vapor barriers, flashing, etc., and we strongly advise consulting this report.

There are a few specific guidelines in both house design and orientation which must be considered to accommodate an active solar heating system. The ideal orientation of the house is true south, which generally varies from magnetic south. In Jaffrey, N.H., true south is about 15° west of magnetic south. Architectural Graphic Standards provides the exact deviation figures for all locations in its isogonic map. Sometimes other site considerations will prohibit this exact orientation; a deviation of 20° east or west of true south will still be acceptable.

For roof-mounted collectors, the optimum roof angle is equal to the latitude of the site plus about 15°. There is great room for variation from this figure in applications in New England; the limiting figure at the low end would be about 45° in order to assure effective thermal siphoning to prevent summertime overheating of the collectors. This figure is related to the collector length specified, as noted in Table 1.

Array Angle to Horizontal	Maximum Length
40 degrees	12 ft.
45	14
50	16
55	18
60	20
65	20
70	20
80	20
90	20

Table 1.

Array Elevation

An additional consideration would be to avoid any shading of the collectors by either evergreen trees near the house or by elements of the building itself. In calculating possible tree shading effects, a close estimate for this latitude is to make certain the angle to the horizon generated by a line from the top of the tree to the base of the collector is less than 20°.

An excellent source for further discussion of energy-efficient house design is Bruce Anderson's The Solar Home Book.

SOLAR SYSTEM SIZING

Solar energy is an economical supplementary heat source. Solar sufficiency is the percent of the total annual heating load carried by the solar system. While a system can be designed to carry any portion of the load desired, cost effective solar design generally utilizes solar sufficiencies between 25 and 65%. The size of the collector array, and consequently the size of the storage and air transport subsystems, must be chosen according to several criteria:

1. Overall system effectiveness on a cost vs. return basis.

2. Ability to comply with the budget of the total project.

3. Compatibility with the roof or wall area that is available for collector mounting.

There are several computer programs available to calculate solar sufficiency and the related economics of a given solar installation.

SOLCOST is a readily available program that can provide this analysis.

A method for approximate sizing of our warm air solar space heating system is given below. It gives an approximate ratio of collector area to building floor area for a 50% solar sufficiency. Annual degree days of the climate and the heat loss characteristic of the building are required. We recommend this method be used in the initial planning stages of the building. A more accurate determination of solar sufficiency should then be made using SOLCOST or a similar computer sizing program The system size can then be adjusted to the desired solar sufficiency as based on project economics and architectural requirements.

Climate Region (DD/year)

Normalized Heating Load $\left(\frac{BTU/DD}{ft^2}\right)$ — 50 % Solar Sufficiency	5000	6000	7000	8000	9000
4	.12	.14	.17	.19	.21
5	.15	.18	.20	.23	.26
6	.18	.21	.24	.29	.31
7	.20	.24	.29	.33	.37
8	.23	.29	.33	.37	.42

Table 2 Collector Area/Floor Area

1. Heat Loss

Calculate the building heat loss in $\frac{BTU/°F}{HOUR}$. Include heat loss through all surfaces and a reasonable loss due to air change (infiltration).

2. Normalized Load

Calculate the normalized heating load: multiply the house heat loss per hour at the design temp. by 24. Then divide this by the product of house DELTA-T times the total floor area.
Normalized Heating Load =

$$\frac{24 \text{ Hrs.} \times \text{building heat loss/°F}}{\text{area of heated space}}$$

3. Collector Area:Floor Area Ratio

Given the degree days per year of the site and the Normalized Heating Load, find the collector area/floor area ratio from Table 2.

4. Active Collector Area

Multiply the square footage of heated space by the collector area/floor area ratio. This gives the approximate active collector area needed to achieve 50% solar sufficiency:

(Active Collector Area) =

$$(\text{Area of Heated Space}) \times \frac{(\text{Active Collector Area})}{(\text{Floor Area})}$$

5. Gross Collector Area

To derive the gross collector area, which is necessary for design calculations, multiply the active area by 1.15:

(Gross Collector Area) =

(Active Collector Area) x (1.15)

NOTE: the above sizing method is only an approximation. It is based on applications of the CSI integrated warm air solar heating system in energy efficient construction and solar insolation data for Concord, N.H. Areas with distinctly lower solar insolation will have to be derated.

STORAGE DESIGN

1. Storage Sizing

The storage sizing for system configurations taken from Table 2. will require one cubic foot of rock for each square foot of active collector area. For example, a house with a normalized load of $\frac{6 \text{ BTU/DD}}{\text{ft}^2}$ in a 7000 degree day climate will have a collector to house area ratio of (.24). This means that a 1,600 ft^2 house would require (.24)(1,600) - 384 ft^2 of active collector area. This would require 384 ± cubic feet of rock storage.

2. Storage Bin Shape

The shape of the storage bin is determined primarily by the face velocity of air through stone:

a) Calculate the total air volume/min. (in CFM):

$$\frac{3 \text{ ft}^3\text{/min.}}{\text{ft}^2 \text{ collector}} \times \text{collector active area} = \text{volume/min.}$$

b) Multiply the volume/min. by 25, a desirable face velocity, to determine the cross sectional area of the storage (Height x Width) perpendicular to the air flow:

Volume/min. x 25 =

Cross Sectional Area of Storage (HxW)

This figure for HxW can be allowed to vary ±20% and still assure good flow distribution without unnecessarily high pressure drops through the storage system. The final determination of Height and Width depends on the additional parameters explained in Figure 2.

3. Stone Selection

The stone specification requires a washed and screened stone in a size range from 1 to 1-1/2" average diameter. This stone is generally in the form of "trap rock" in the New England area and is used for septic system fields or foundation drainage and is usually readily available.

The sizing is important since it affects the storage pressure drop. See Table 3. for evaluation of pressure drop.

Path Length (L)	Face Velocity 20	25	30
6	--	.14	.20
8	.08	.18	.27
10	.11	.23	.33
12	.15	.28	.40

Table 3.

Pressure Drop Across Storage

NOTES:

1) Pressure drop is in inches of water.

2) Add .10" to calculated value to account for storage manifold losses.

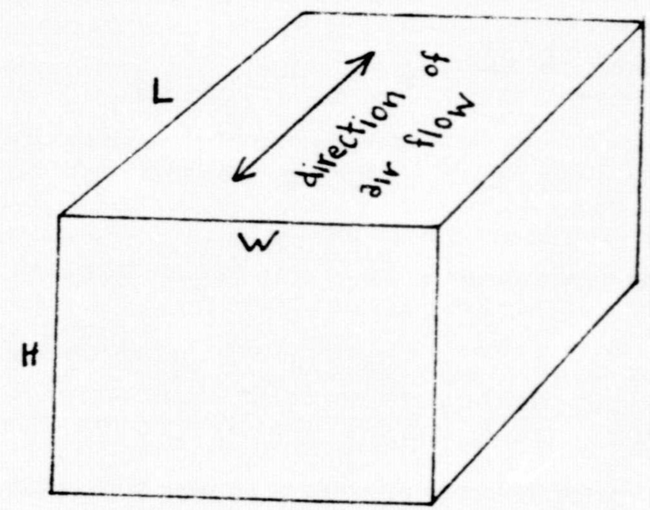

Figure 2.

Storage Bin Configuration

A. HxW = Cross-sectional area perpendicular to air flow.

B. The ratio of W:H should be no greater than 3 nor less than .3.

C. The ratio of $L:\frac{W+H}{2}$ should be no greater than 2 nor less than 1.

D. L should be between 6 and 12 feet.

NOTE: L, W. H are inside dimensions occupied by stone. Allow additional size for manifolds, insulation and cap.

TRANSPORT SYSTEM

1. Collector Manifolding

The collector manifolding will generally be fabricated of a rectangular or square duct of approximately one-half the cross-sectional area of the solar ducting. The manifold will interconnect to the 8" round takeoff collars on the collector I/O ports. All of the cold ports of the array will be connected in parallel as will all of the warm ports. A flexible 8" duct will connect the collector takeoff collar to the manifold takeoff collar. The manifold takeoff collar on either hot or cold side will have an adjustable locking volume damper for system balancing. See Figure 3. It is of special importance to make all interconnections air tight and to insulate all ducting in accordance with the enclosed table CSI #240-001.

2. Fail-Safe Vents

A sufficient number of fail-safe thermal vent valves and ports must be provided so that the system can thermosiphon enough air to cool it below damaging temperatures. Thermal vent ports are used in pairs, an intake to the collector cold manifold and an exhaust from the collector hot manifold. There are two criteria for determining the number of ports needed and their spacing:

1) A pair of ports must be provided for every 350 ft^2 of active collector area.

2) Ports should be provided for every 24 linear feet of collector manifold.

The vent port is generally fitted to the gable end panel of the house via a 10" insulated flexible ducting. Reference CSI Drawing #530-001.

3. USU Motor Sizing

The USU should be ordered with the proper electric motor, sized to run the fan at the proper CFM as follows:

Active Collector Area	Motor
100-250 ft^2	1/3 HP
250-350 "	1/2 HP
350-600 "	3/4 HP

4. Duct Sizing

The inside dimensions of the solar system's interconnecting ducting are chosen by one criterion: linear air velocity in the ducts must be not greater than 1000 ft./min. Calculate the duct's inside dimensions (HxW) by:

a) Calculate the system's air flow. Multiply the active area of the collector array by 3 to obtain system CFM (cubic feet per minute):

$$\text{(active area)} \left\{\frac{3\ \text{CFM}}{\text{ft}^2}\right\} = \text{system CFM}$$

b) Calculate the duct's minimum inside area (HxW)min. by dividing the system CFM by 1000:

$$\text{duct inside area ft}^2 \geq \frac{\text{system CFM}}{1000\ \text{ft./min.}}$$

c) Choose duct inside dimensions H and W (in ft.) to be compatible with the building design and:

TOLERANCES EXCEPT AS NOTED	TITLE: COLLECTOR MANIFOLDING	
DECIMAL ±	PROJECT: COLLECTOR/MANIFOLD	
FUNCTIONAL ±	INTERCONNECT	
ANGULAR ±		
REVISIONS	DRAWN BY: JCB	CHECKED BY
	SCALE	DRAWING # 570-001

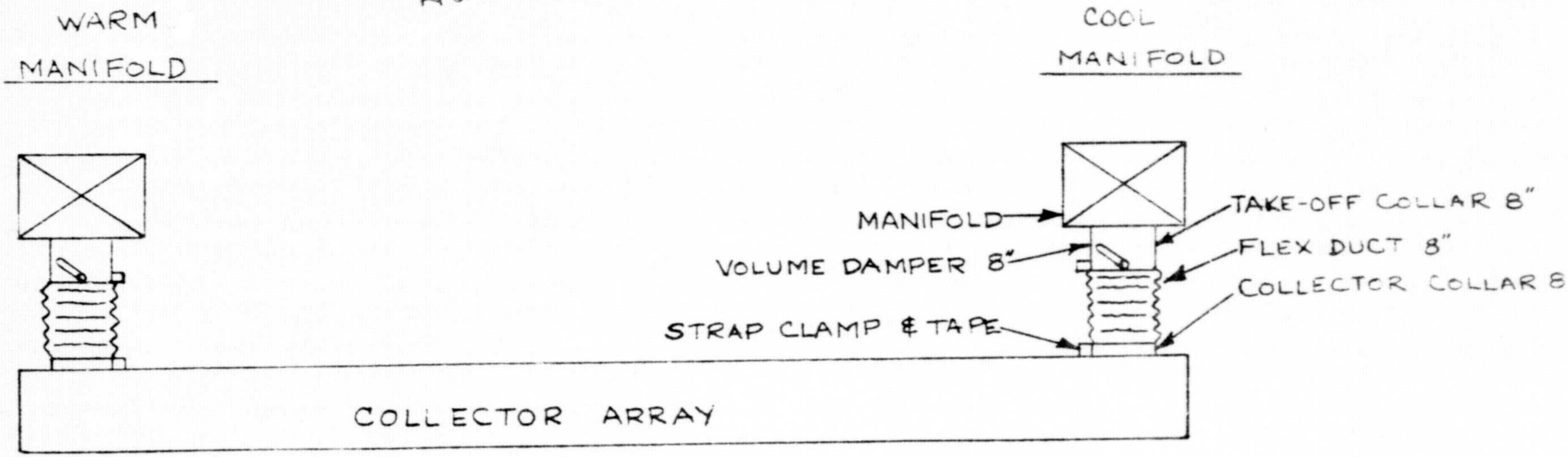

Fig. #3

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$H \times W \geq$ duct minimum inside area

d) Duct outside dimensions will depend on the required duct insulation. Consult the duct insulation requirements in the general specifications. CSI # 240-001

APPENDIX TO DESIGN DATA BROCHURE

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CSI#-240-001

DUCTING/ MANIFOLDING INSULATION REQUIREMENTS

1) Manifolding:

A. Hot manifold; assume output temperature of 120°F.

Average temp. surrounding manifold	Suggested manifold insulation	Tolerance
0° F.	R-10	Loss must not exceed
20°	R-8	0.7% of total system
40°	R-6	output; verify loss is
60°	R-4	within this spec.

B. Cold manifold; assume input temperature of 65°F.

0°	R-8	Loss must not exceed
20°	R-6	0.7% of total system
40°	R-4	output; verify loss is
60°	R-2	within this spec.

2) Ducting, exterior to heated living space:

A. Hot ducting; assume output temperature of 120°F.

0°	R-12	Loss must not exceed
20°	R-10	1.0% of total system
40°	R-8	output; verify loss is
60°	R-6	within this spec.

B. Cold Ducting; assume input temperature of 65°F.

0°	R-6	Loss must not exceed
20°	R-5	0.7% of total system
40°	R-4	output; verify loss is
60°	R-3	within this spec.

3) Ducting; inside heated space:

A. Hot ducting; assume air temperature of 120°F.

40°	R-5	Loss must not exceed
50°	R-4	6% of total system
60°	R-4	output; verify loss is
70°	R-3	within this spec.

B. Cold ducting; assume air temperature of 65°F.

40°	R-3	Loss must not exceed
50°	R-3	2% of total system
60°	-	output; verify loss is
70°	-	within this spec.

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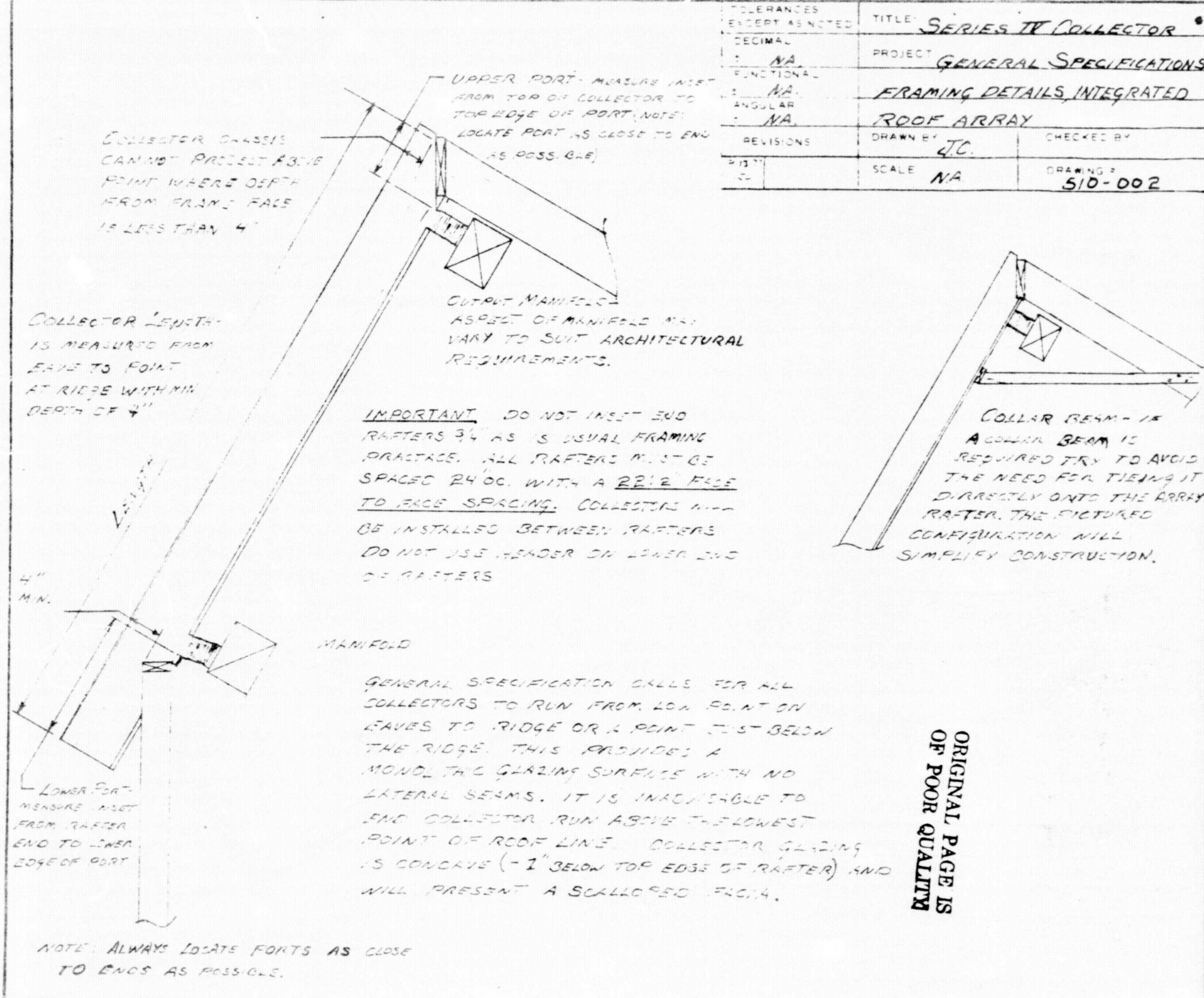
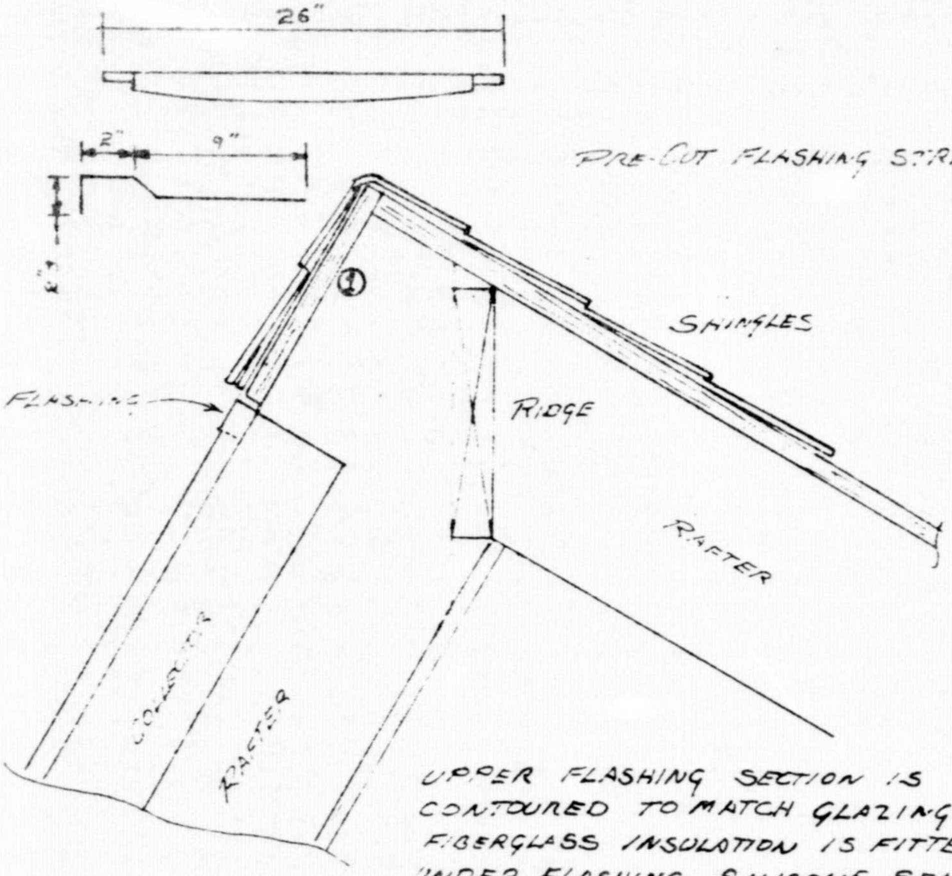
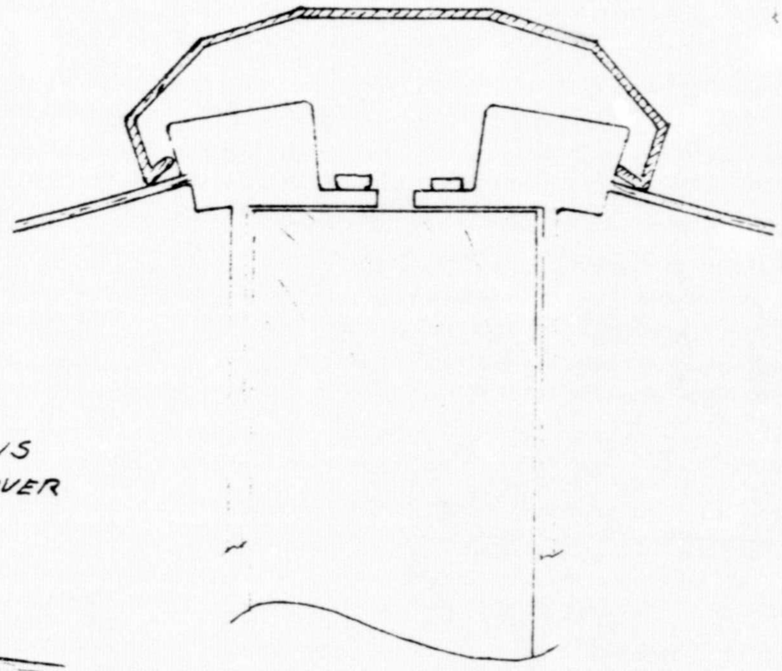


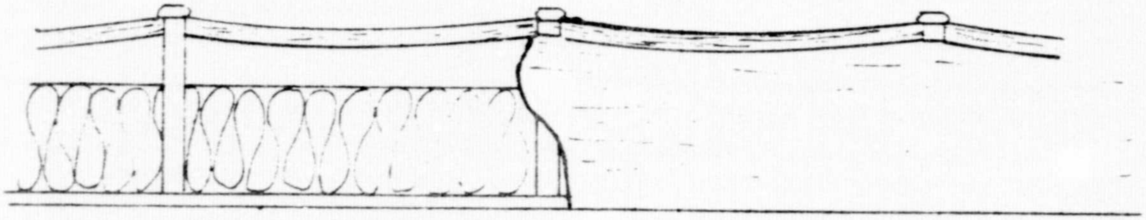
TOLERANCES EXCEPT AS NOTED	TITLE: SERIES IV COLLECTOR	
DECIMAL ±	PROJECT GENERAL SPECIFICATIONS	
FUNCTIONAL ±	FLASHING & TRIM	
ANGULAR ±		
REVISIONS	DRAWN BY JC.	CHECKED BY
6·3·77 JC / 9·13·77 JC	SCALE	DRAWING # 510-005



UPPER FLASHING SECTION IS CONTOURED TO MATCH GLAZING. FIBERGLASS INSULATION IS FITTED UNDER FLASHING. SILICONE SEAL IS PLACED BETWEEN FIBERGLASS COVER AND FLASHING.



SNAP FIT BATTEN CAP AT COLLECTOR INTERSECTION.



LOWER FACIA 1/2" STOCK FITTED TO LOWER CONTOUR OF COLLECTOR GLAZING.

① TWO PIECES OF 5/8" SHEATHING USED AT COLLECTOR HEAD TO BRING ELEVATION OF ROOFING EQUAL WITH BATTEN CAPS.

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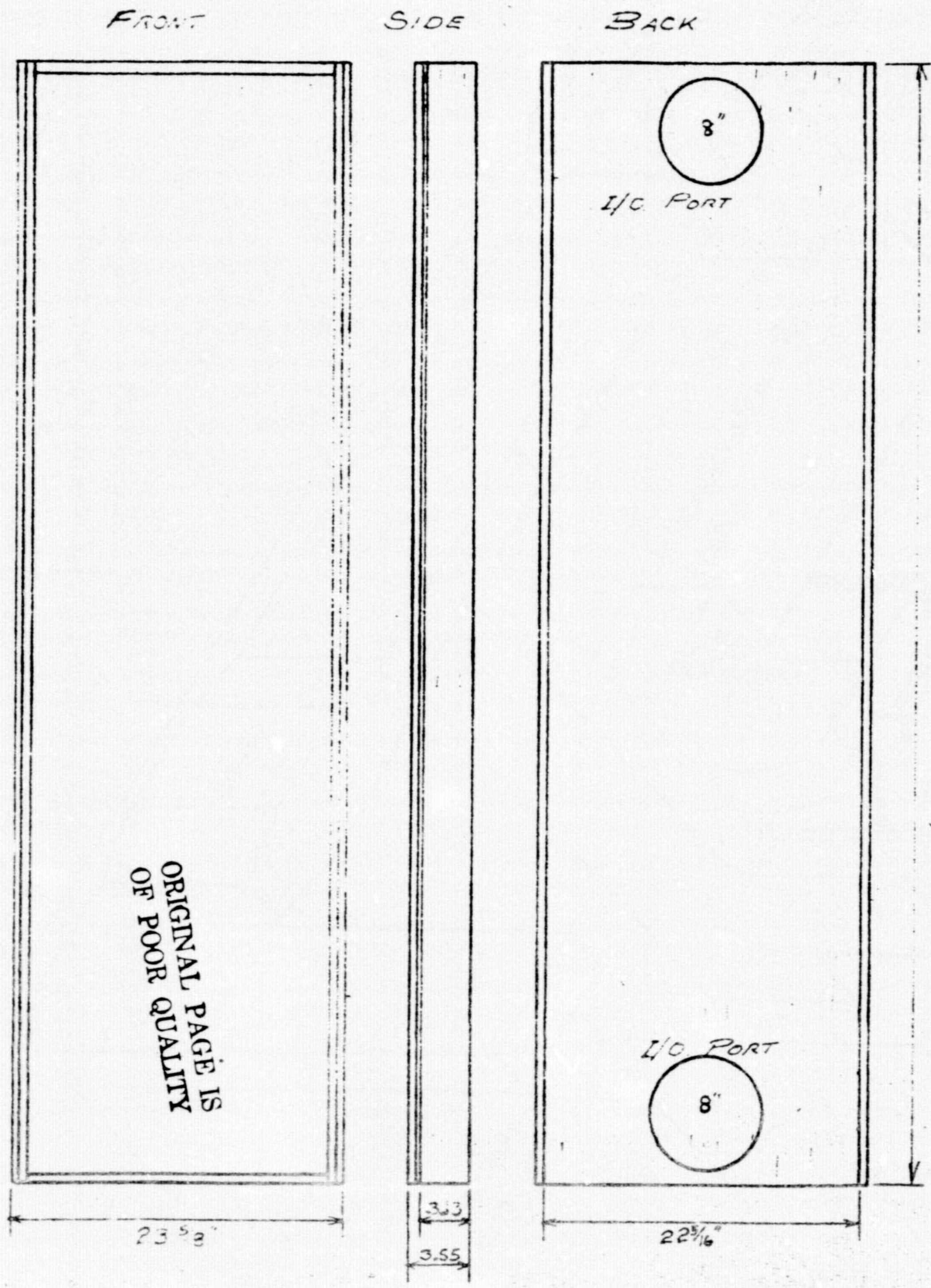
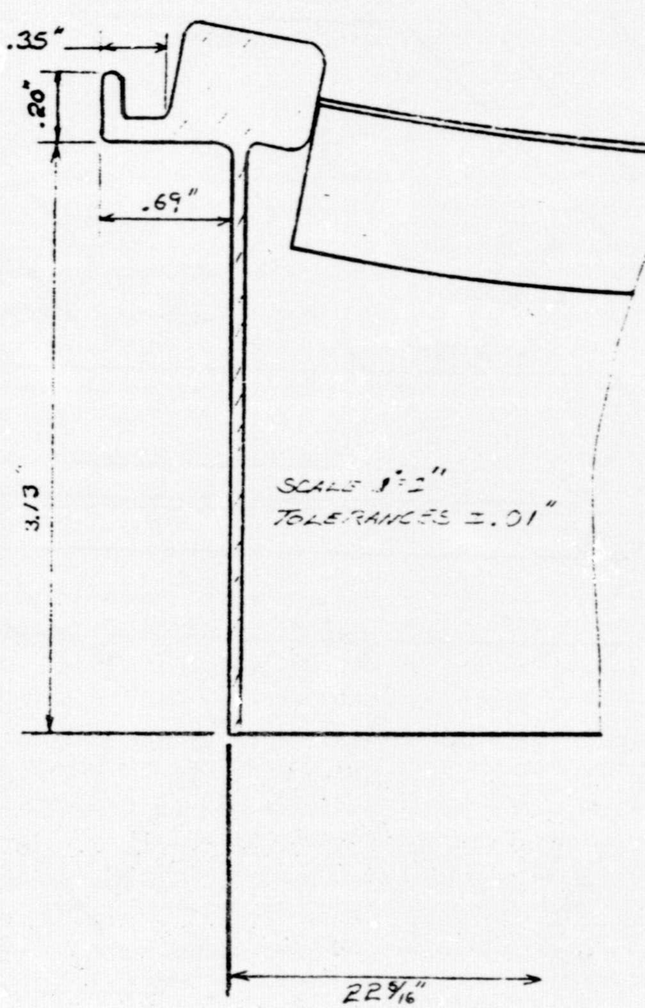
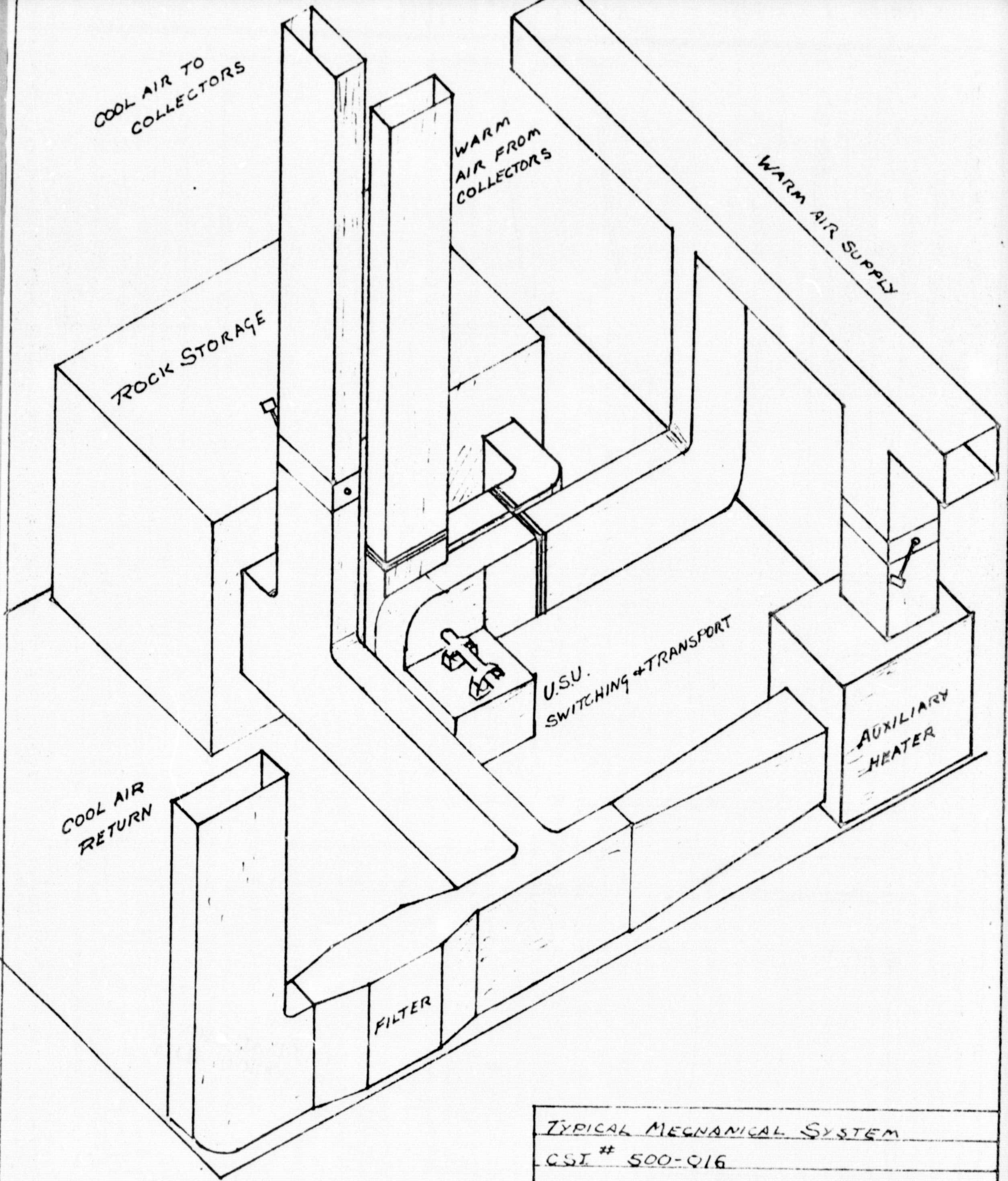
TOLERANCES EXCEPT AS NOTED	TITLE: SERIES V COLLECTOR, 2X	
DECIMAL ± .04"	PROJECT GENERAL SPECIFICATIONS	
FUNCTIONAL ± 1/16"	COLLECTOR EXTERNAL	
ANGULAR ± NA	DIMENSIONS	
REVISIONS	DRAWN BY JC 6-3-77	CHECKED BY
9-13-77 JC	SCALE 2" = 1'	DRAWING # 510-007







TYPICAL MECHANICAL SYSTEM

CSI # 500-016

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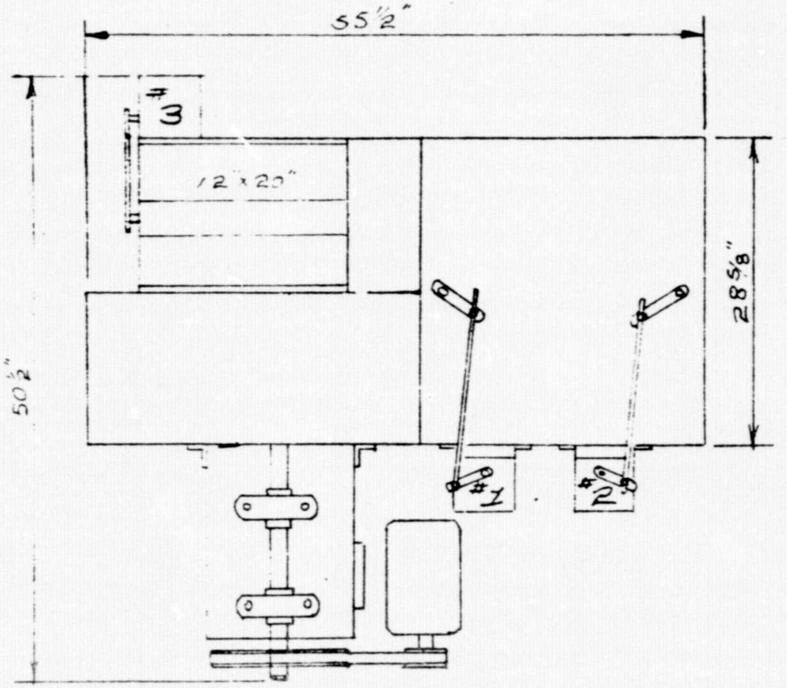
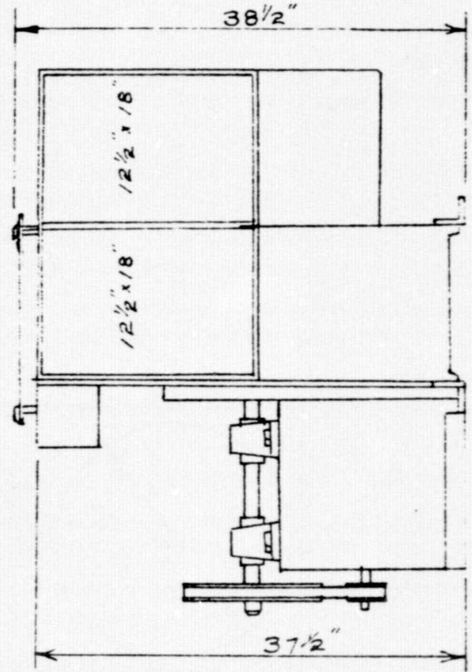
MATERIALS: Fan;Cold rolled steel chassis w/ rust preventive paint Valve box; 24 Gauge galvanized steel chassis,nylon bearings, cold rolled shaft,PVF filmblade wipers. Damper motor; Honeywell M836-A 24 VAC. Linkage; cold rolled steel stamped pcs.

TOLERANCES EXCEPT AS NOTED	TITLE: USU-A Dimensions	
DECIMAL ±	PROJECT General Specifications	
FUNCTIONAL ± 3/8"		
ANGULAR ±		
REVISIONS	DRAWN BY J.C. 4-4-77	CHECKED BY
	DRAWING # SEC-...	





Unit may be broken down into two components for installation thru 32" min. passage door.

Fan Unit

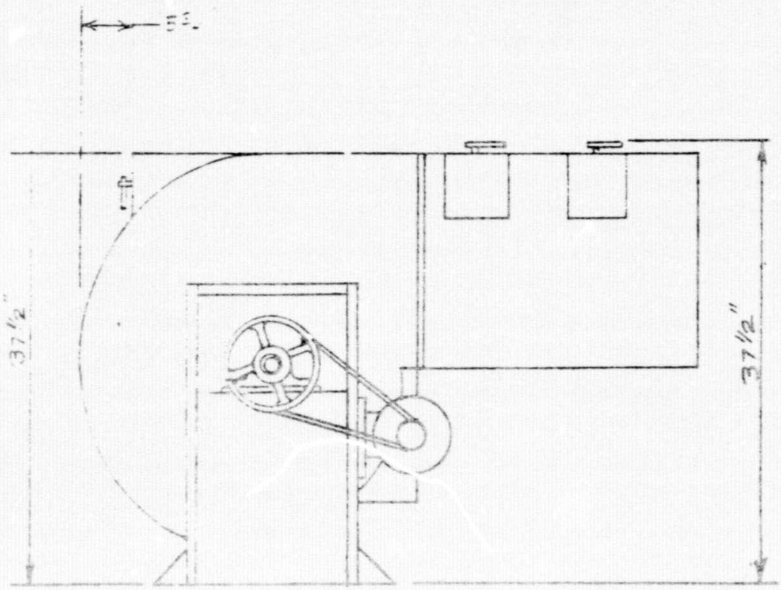
34"Wx30$\frac{1}{2}$"Dx36$\frac{1}{2}$"H

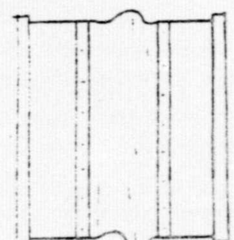
Switching Unit

36$\frac{1}{2}$"Wx52"Dx30$\frac{1}{2}$"H

Assembled Unit

50$\frac{1}{2}$"Wx55$\frac{1}{2}$"Dx38$\frac{1}{2}$"H





Output from USU is 12½"x 18"
Output boot can taper to accomodate any duct size.
Flexible coupeling assures quite operation.

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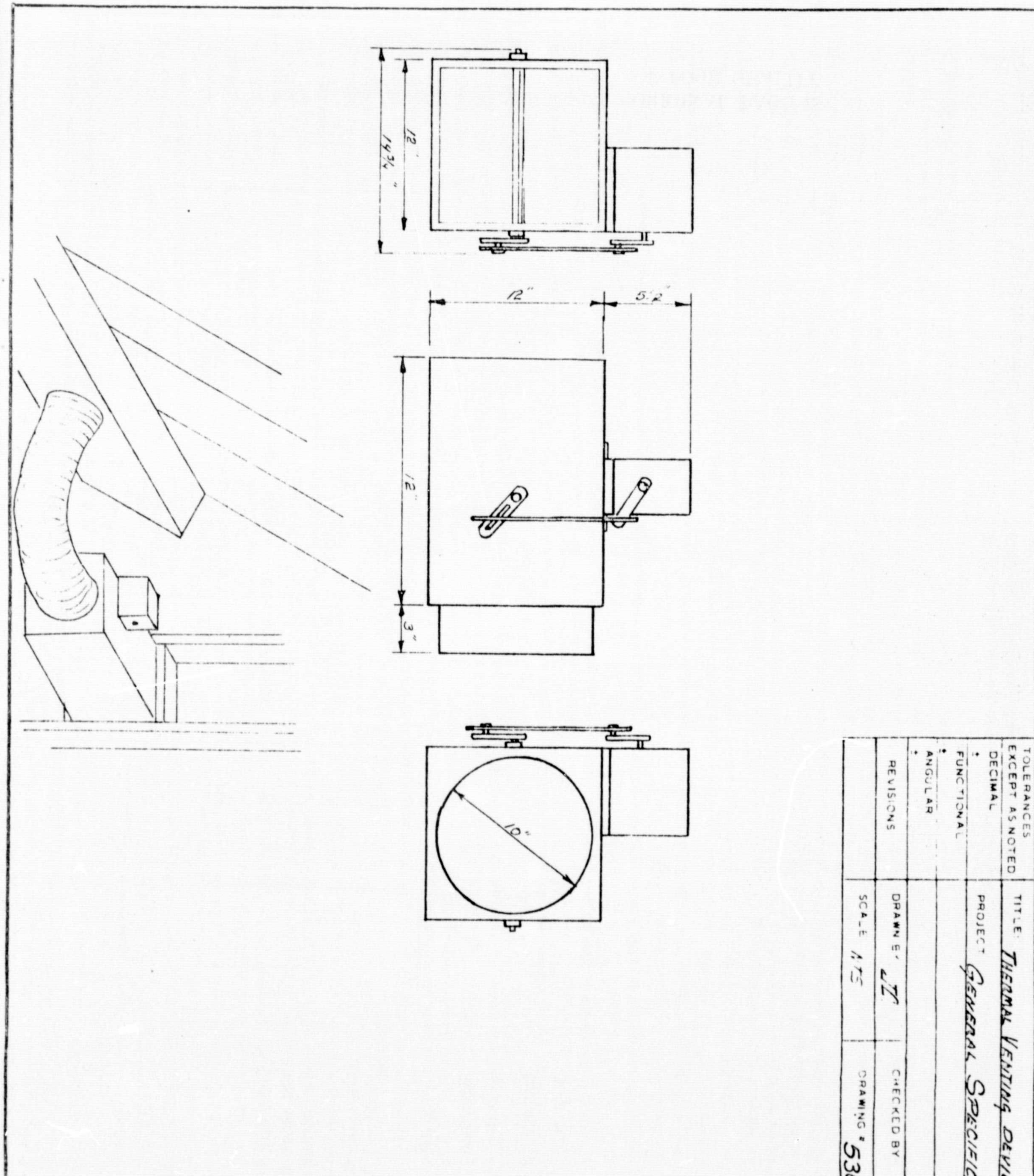

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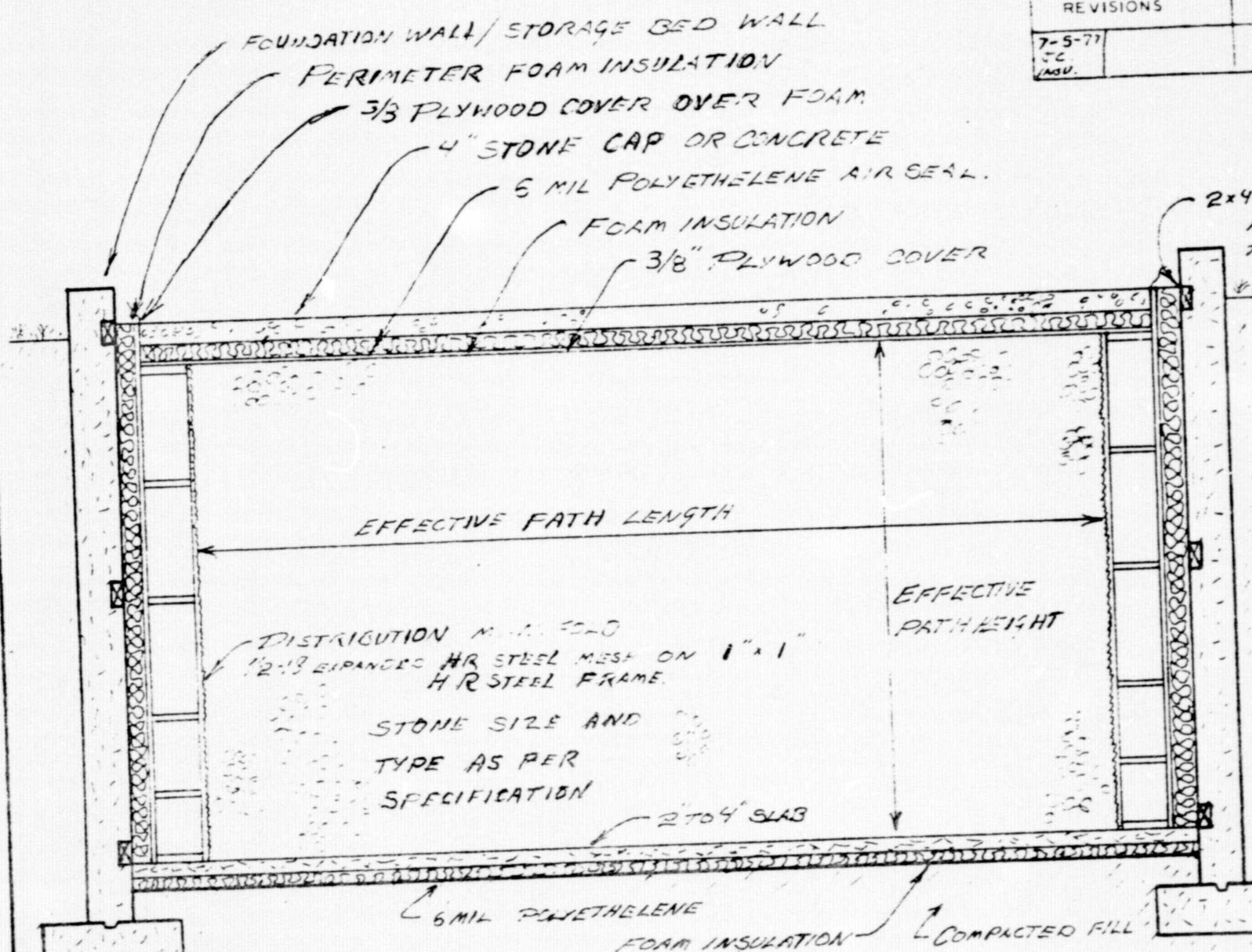
EXCEPT AS NOTED	TITLE ROCK STORAGE SECTION	
DECIMAL ±	PROJECT GENERAL SPECIFICATIONS	
FUNCTIONAL ±		
ANGULAR ±		
REVISIONS	DRAWN BY J.C.	CHECKED BY
7-5-77 J.C. NSU.	SCALE NTS	DRAWING # 540-002



ROCK BED
INSULATION SPECIFICATION

Storage walls common to areas whose temperatures are:

Above 60°F	Ins	Wall	Total
Top	R7.5	1.75	9.25
Perimeter	R7.5	1.75	9.25
Above 30°F			
Top	R11	"	12.75
Peremeter	R11	"	12.75
Above 0°F			
Top	R15	"	16.75
Perimeter	R15	"	16.75
Above -30°F			
Top	R19	"	20.75
Perimeter	R19	"	20.75

Suggested Insulation type; Isocyanurate Foam, foil faced Celotex Thermax TF-600 or 610 @ R-8 per inch.

BOTTOM INSULATION: is suggested in most installations, R3 to R6 is generally satisfactory. Additional insulation may be required if much ground water movement is present.

WATER PROOFING: The entire bin must be water and damp proofed. Dampness in contact with the warm stones may proove to be a health hazard.

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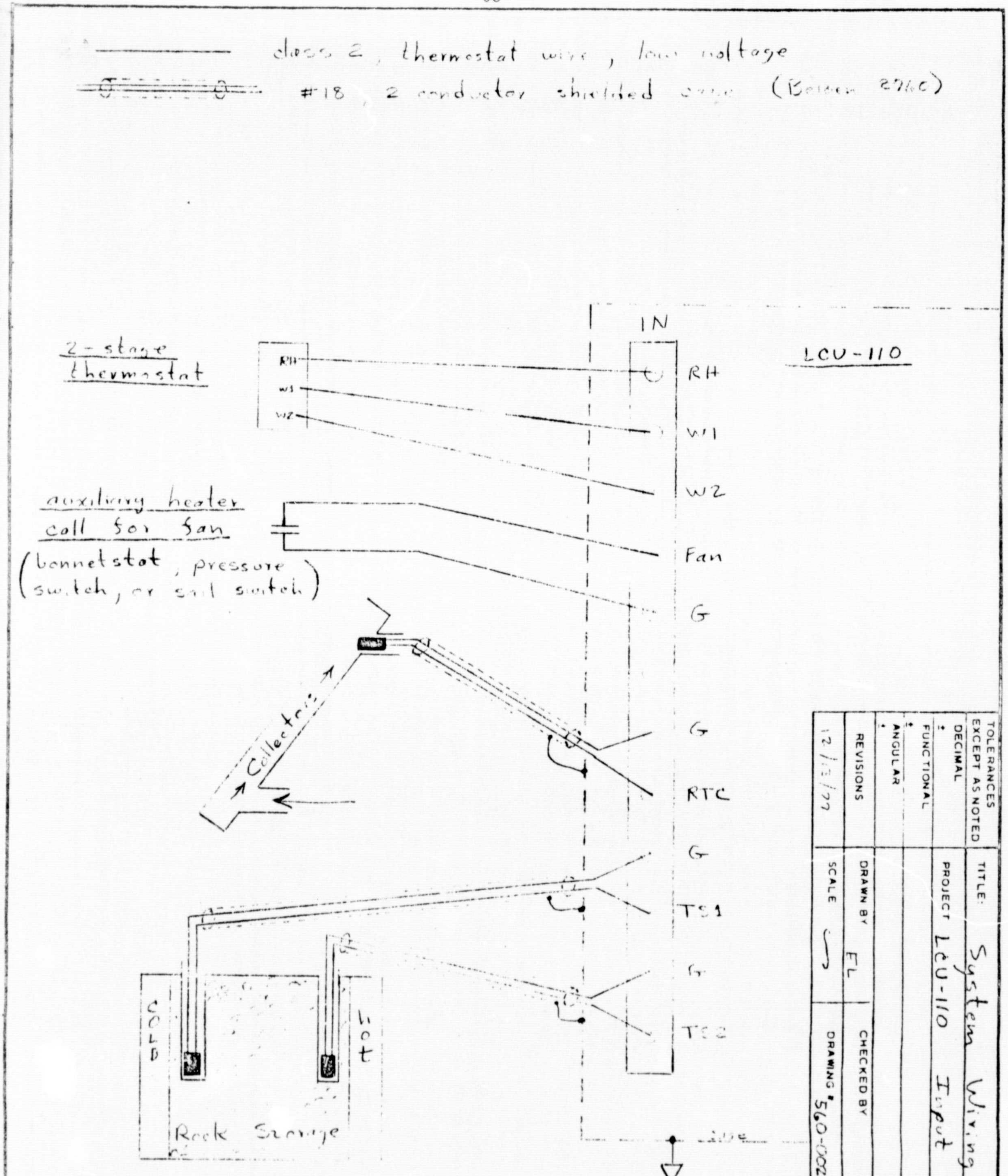

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class 2 low voltage wiring

class 1, high voltage wiring

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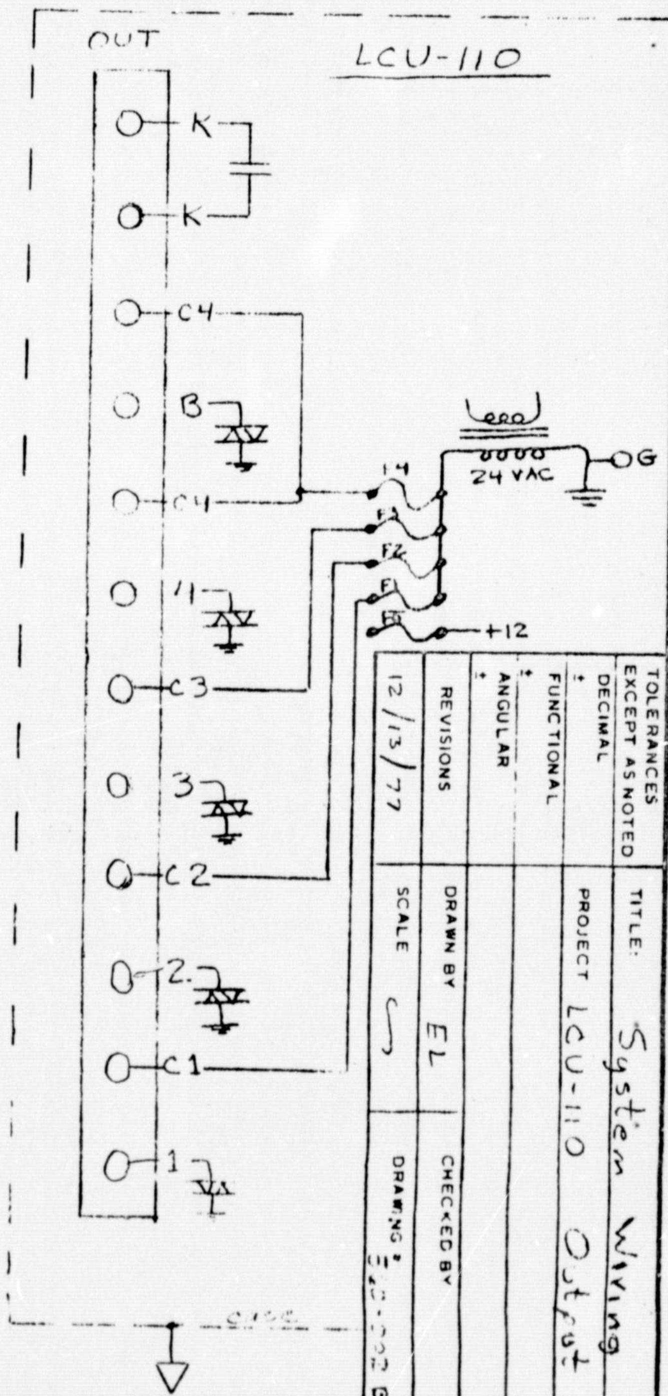

TOLERANCES EXCEPT AS NOTED	TITLE: System Wiring Output
DECIMAL ±	PROJECT LCU-110
FUNCTIONAL ±	
ANGULAR ±	
REVISIONS	DRAWN BY EL
12/13/77	SCALE
	CHECKED BY
	DRAWING #

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PURCHASING SPECIFICATIONS

CSI #1000-006

CSI COMPONENTS

Series V Collector sub-system:

Collectors: _____ units ______ feet in length (nominal 2' in width)

Batten caps. _____ units _____ feet in length (same length as collectors)

Top flashing: _____ pieces _________ depth (one per collector unit, normal depth 8")

Fail-Safe Thermal Vents: _____ units

Control sub-system:

LCU-110 Logic Control Unit _______

Sensor probes: _____ units

Switching and transport sub-system:

USU: motor type: GE Energy Saver
motor capacity: ______HP

HVAC COMPONENTS

Auxiliary furnace: ____________________type ___________ size______________

Interconnecting duct work:

Collectors/USU: ______ size_______ feet ________ insulation

USU/storage: ______ _______ ________

PURCHASING SPECIFICATIONS (CONTINUED)

CSI 1000-006

Storage/Collector: ________ ________ ________

Storage/house: ________ ________ ________

USU/house: ________ ________ ________

Other: ________ ________ ________

System Wiring:

Collector manifolding: ________ type (3 or 4 sided)

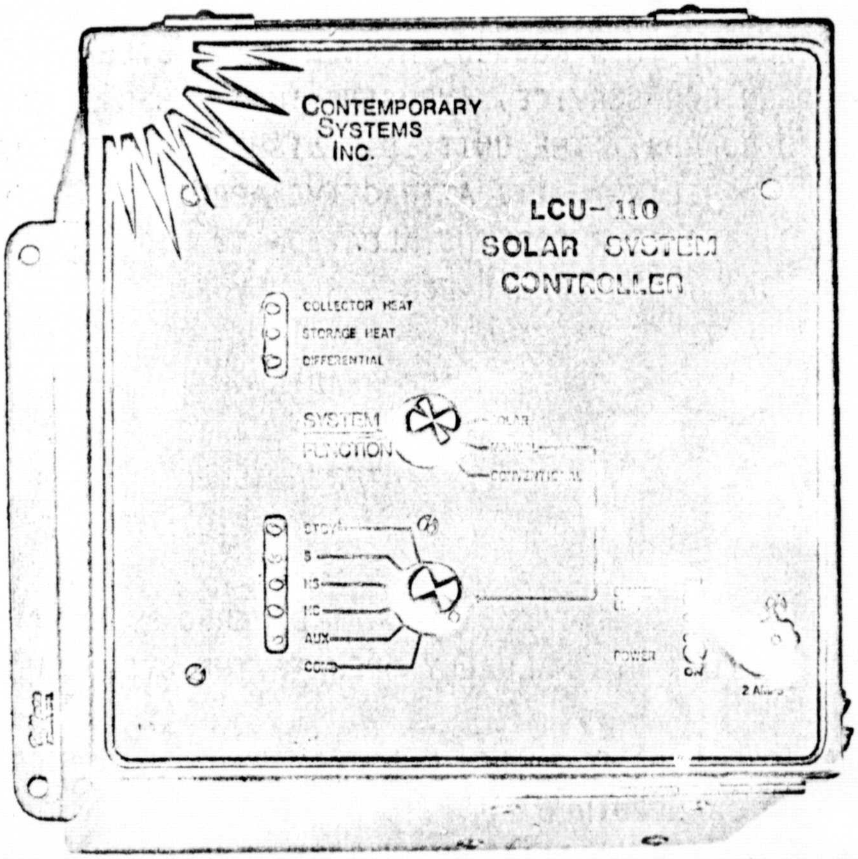
________ total length

Balancing Valves: ________ type (internal or external)

________ units (one per collector)

THE SOLAR CONTROLLER

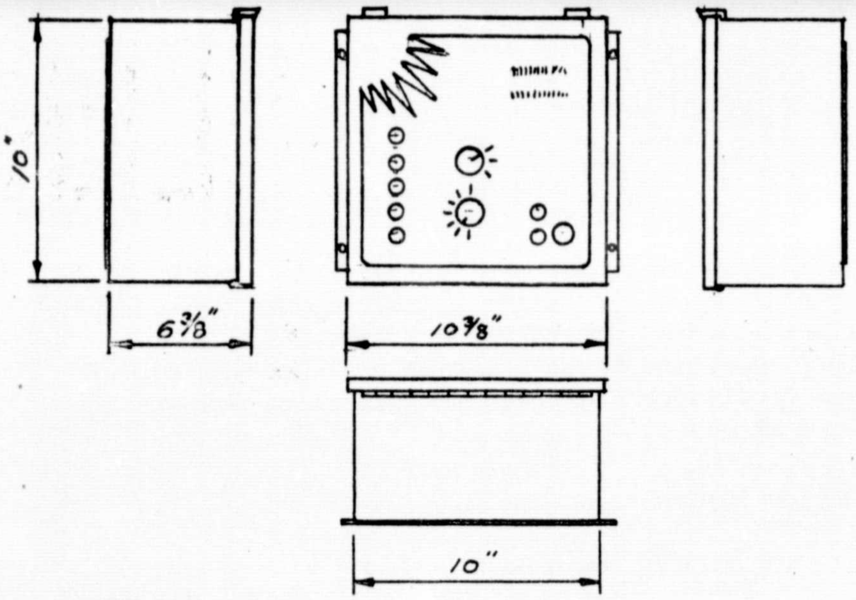
CONTEMPORARY SYSTEMS, INC.
LOGIC CONTROL UNIT
LCU-110



DESIGNED FOR OPTIMUM CONTROL CAPABILITY IN AIR TYPE SOLAR SPACE HEATING SYSTEMS.

THE ADVANCED COMPUTER STYLE CONSTRUCTION TECHNIQUES PROVIDE RELIABLE OPERATION AND EASILY ACCESSIBLE BOARD REPLACEMENT SERVICING.

THE VERSATILE SOLAR CONTROLLER



THE LCU—110 MAY BE SURFACE MOUNTED OR RECESSED INTO THE WALL AS A DECORATIVE FEATURE IN THE LIVING AREA.

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THE LCU-110 IS HOUSED IN A RUGGED, HINGED-FRONT STEEL CABINET. THE FRONT PANEL SWINGS DOWN FOR SERVICE, EXPOSING THE MOTHER BOARD WITH THE PLUG-IN LOGIC AND I/O BOARDS. THE UNIT IS FINISHED IN A HAMMERTONE GRAY WITH DISTINCTIVE BLUE LABELING. ITS ATTRACTIVE APPEARANCE AND L.E.D. READOUT LIGHTS MAKE IT SUITABLE FOR INSTALLATION IN HIGH VISIBILITY AREAS. THE UNIT MAY BE FRAMED INTO THE WALLS FOR A HIGHLY FINISHED APPEARANCE OR SURFACE MOUNTED IN THE UTILITY AREA.

THE LCU-110 IS DESIGNED TO INTERFACE READILY WITH CONVENTIONAL BACK-UP HEATING SYSTEMS AND IS EASILY ADAPTABLE TO A VARIETY OF SOLAR SYSTEM CONFIGURATIONS. IT IS EQUIPPED WITH AN INTERNAL ELECTRONIC CLOCK WHICH ASSURES ACCURATE TRANSITIONS BETWEEN MODES AND EFFICIENT USE OF ALL AVAILABLE SOLAR AND AUXILIARY ENERGY.

THIS SYSTEM WILL PROVIDE TOTALLY AUTOMATED PERFORMANCE AND YET ALLOWS THE OWNER THE ABILITY TO MANUALLY OPERATE THE SYSTEM WHEN DESIRED.

THE LCU-110 IS SOLD COMPLETE WITH THREE THERMISTOR SENSOR PROBES. A TWO-STAGE THERMOSTAT IS REQUIRED FOR SENSING ROOM TEMPERATURE. THE UNIT IS SHIPPED FULLY WIRED AND READY FOR INSTALLATION.

PRICE: 584 DOLLARS • FOB JAFFREY, N.H.

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LCU-110 LOGIC CONTROL UNIT

Functional Description

The LCU-110 is designed to function as the primary control component for air circulating solar heating systems. It controls the total operation of the active collection/distribution/storage systems as well as calling for auxiliary energy. Control of the system fan includes shutdown during transition between solar operating modes. The control package monitors collector, storage, and room temperature conditions and selects appropriate outputs to maximize solar usage and minimize auxiliary system operation.

SPECIFICATIONS

Control Inputs
(Located on terminal strip on mother board)

1. Collector (hot) probe
2. Storage (hot) probe
3. Storage (cold) probe
4. Room Thermostat, Stage #1 (IPC 1.7.3)
5. Room Thermostat, Stage #2
6. Auxiliary call for fan

Control Outputs
(Located on terminal strip on mother board)

1. Damper #1 motor (24 V AC-1.85A)
2. Damper #2 motor (24 V AC-1.85A)
3. Damper #3 motor (24 V AC-1.85A)
4. Damper #4 motor (24 V AC-1.85A)
5. Call for solar fan (24 V AC-1.85A)
6. Call for auxiliary heating source (N.O. relay contacts, 24V AC-1A).

MAXIMUM TOTAL CURRENT FOR COMBINED OUTPUTS 1-5 IS 7.5A.

User Operable Controls and Indicators
(Located on Panel Face)

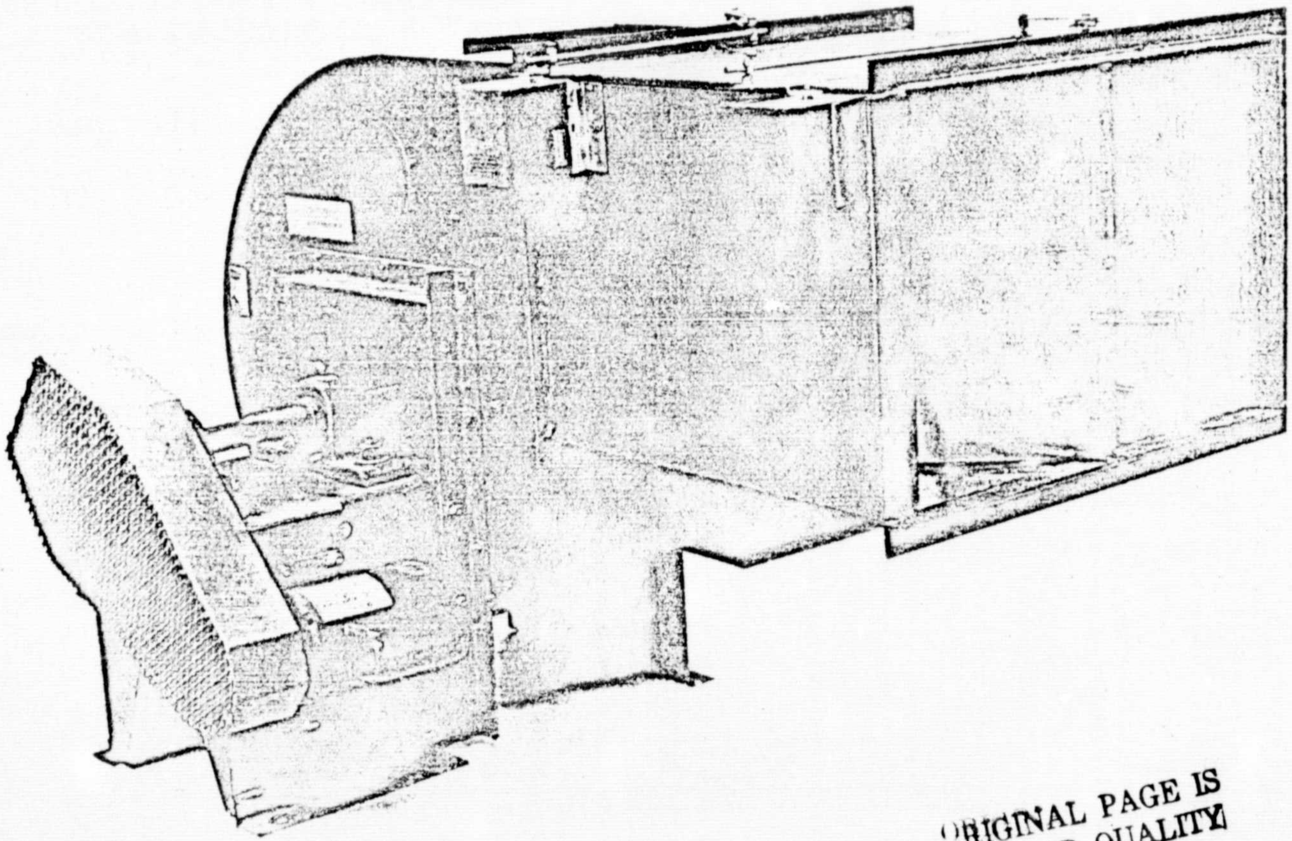
1. System Function Switch:
   a) SOLAR -- automatic operation of solar and auxiliary heating.
   b) CONVENTIONAL -- Room thermostat controls auxiliary unit only, circuit cards may be removed for servicing (I.P.C. 1.7.1).
   c) MANUAL -- In this position, solar system operating mode is selected by the Manual Mode Selection Switch; primarily for startup, testing and servicing.
2. Manual Mode Selection Switch:

Mode	Symbol	Description
Standby	STBY	Waiting for startup data
Storing	S	Storing energy from collectors
Heating from Storage	HS	Retrieving stored energy
Heating from Collectors	HC	Heating from collectors
Auxiliary	AUX	Conventional heating
Combination	COMB	Two simultaneous modes

3. Power Switch: on, off -- 115 V AC.
4. Summer Limit: on, off -- permits storage temperature to be limited during summer operation to $100^{\circ}F$.
5. LED Indicators: Eight lamps, five of which function as mode indicators (STBY, S, HS, HC, AUX), and three as available energy indicators (collector heat, storage heat, collector-storage differential).

THE SOLAR AIR MOVER

CONTEMPORARY SYSTEMS, INC.
UNIVERSAL SWITCHING UNIT
USU-A



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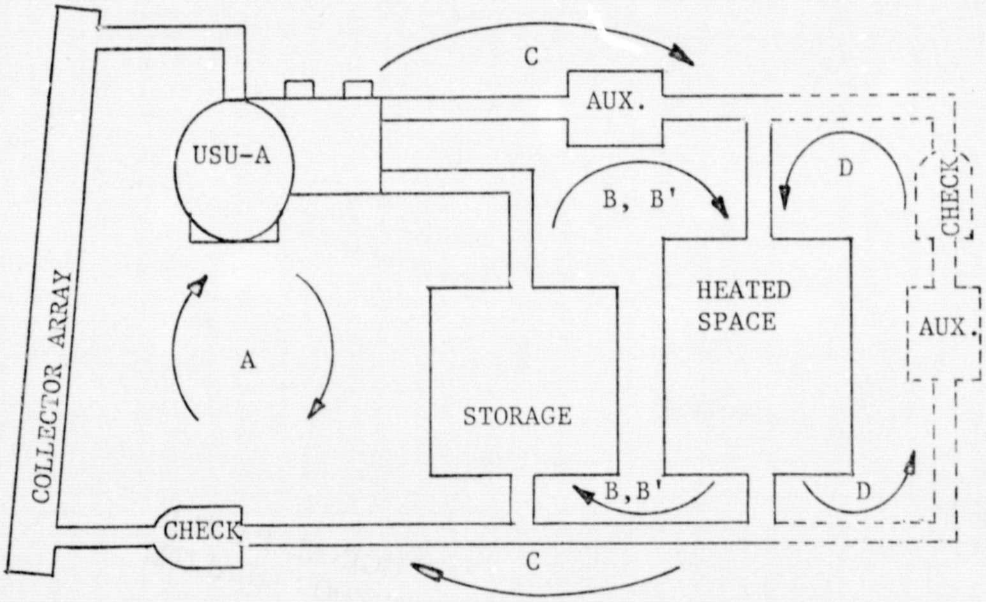
DESIGNED FOR HIGH PERFORMANCE COMMERCIAL
OR LARGE RESIDENTIAL SOLAR AIR HANDLING APPLICATIONS.

THE FAN AND ALL MOTORIZED VALVING REQUIRED
FOR THE THREE BASIC MODES OF SOLAR OPERATION
ARE CONTAINED IN THIS ONE PACKAGE.

THE PREMIUM QUALITY SOLAR AIR MOVER

The Universal Switching Unit USU-A is a combination fan and air valving unit. The fan is a high-performance, backward curve Buffalo Forge® BL 330 driven by a special high-efficiency G.E. motor. The unit is designed to function in the delivery range from 1,200 to 5,000 CFM and at static water pressures from 1/4" to 1-3/4". The valving box is an integral part of the unit and incorporates all valving required to generate the three basic operational solar modes: heating from collectors, storing heat, and heating from storage. This one-piece assembly greatly facilitates system design and installation and provides a uniform quality-controlled package that assures reliable, low-maintenance operation. This unit offers the designer/installer a significant cost advantage in the installed system price. It eliminates the detailed design configuration required with individual valve units and greatly reduces on-site labor during installation. To the end user it offers low maintenance and extremely efficient (low cost) air moving.

The Universal Switching Unit USU-A has undergone NASA-supervised testing which has simulated 15 years of system operation.



A. Storing energy from collectors

B. Heating conditioned area from storage

B'. Heating conditioned area from auxiliary system (series system)

C. Heating conditioned area from collectors

D. Heating conditioned area from auxiliary system (parallel system)

POSSIBLE SYSTEM CONFIGURATIONS USING USU-A

UNIVERSAL SWITCHING UNIT
USU-A

The Universal Switching Unit USU-A is a combination fan unit and air valving box. The fan is a high-performance, backward curve Buffalo Forge® BL 330, designed to function in the delivery range from 1,200 to 5,000 CFM and at static water pressures from 1/4" to 1-3/4". The valving box is an integral part of the unit and incorporates all valving required to generate the three basic operational solar modes; heating from collectors, storing heat, and heating from storage. This one-piece assembly greatly facilitates system design and installation and provides a uniform quality-controlled package that assures reliable, low-maintenance operation.

SPECIFICATIONS

Performance Range:	1,200 to 5,000 CFM .25 to 1.75 inches S.P.
Valve Motors:	24 VAC 1.85 amps nominal opening .6 amps nominal holding 30 sec. nominal opening time 25 sec. nominal closing time Aux. switch 120 VAC, 7.2 amps SPDT adjustable.
Fan:	Buffalo Forge BL 330, backward curve blades, Class 1, arrangement 9.
Prime Mover:	General Electric, Energy Saver high-efficiency motor. Permanent lubricated ball bearing, resilient mounting.
Drive Assembly:	Prime mover equipped with adjustable cast iron sheave. Fan equipped with cast iron sheave. Drive ratio as per specification.
I/O Ports:	Heat from collector duct, 12"x20". Heat to/from storage and room distribution ducts, 12½"x18".
Drive Cover:	Installations where unit will not be located in closed utility area must be equipped with drive cover. This will be fitted as an equipment option.
Duty Cycle:	Continuous.

Leakage Specification -- Control Dampers

Damper	Leakage
USU: warm collector	< 10 CFM @-5/8" water
USU: house	< 14 CFM @+5/8" water (with shaft seal)
USU: storage	< 28 CFM @-5/8" water
Cool collector: return (free float check valve)	< 5 CFM @+.02" water

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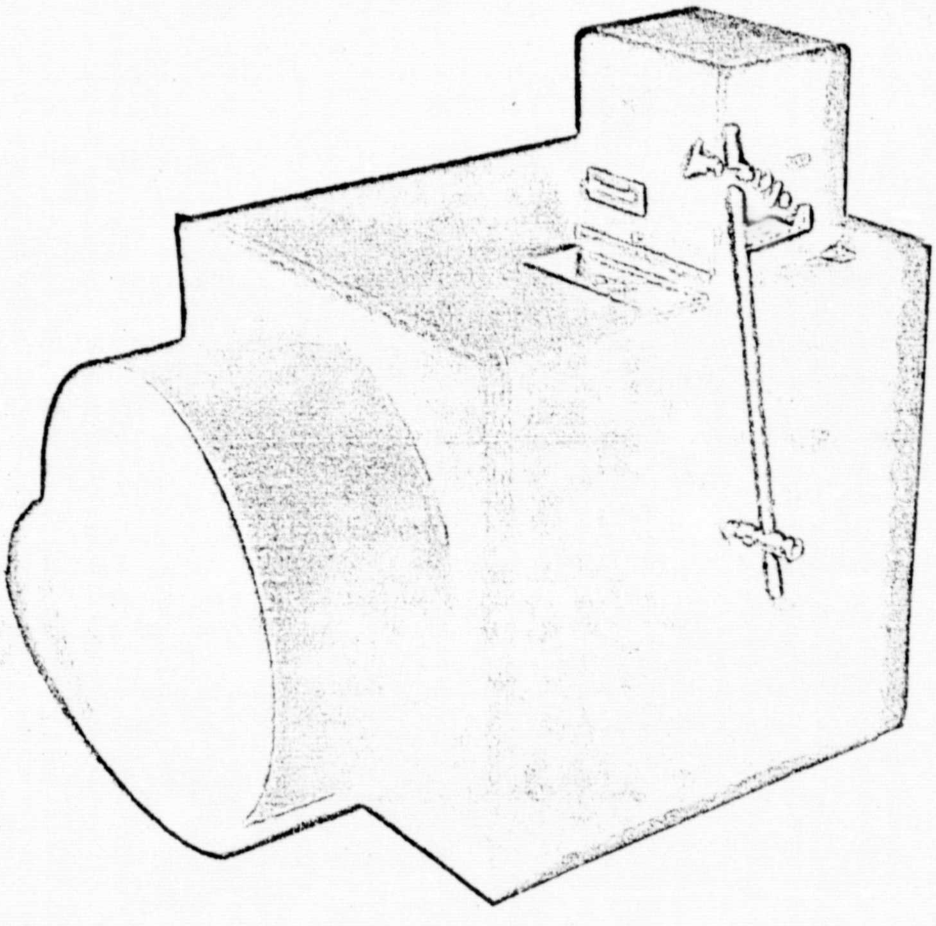
THE FAIL-SAFE VENT VALVE

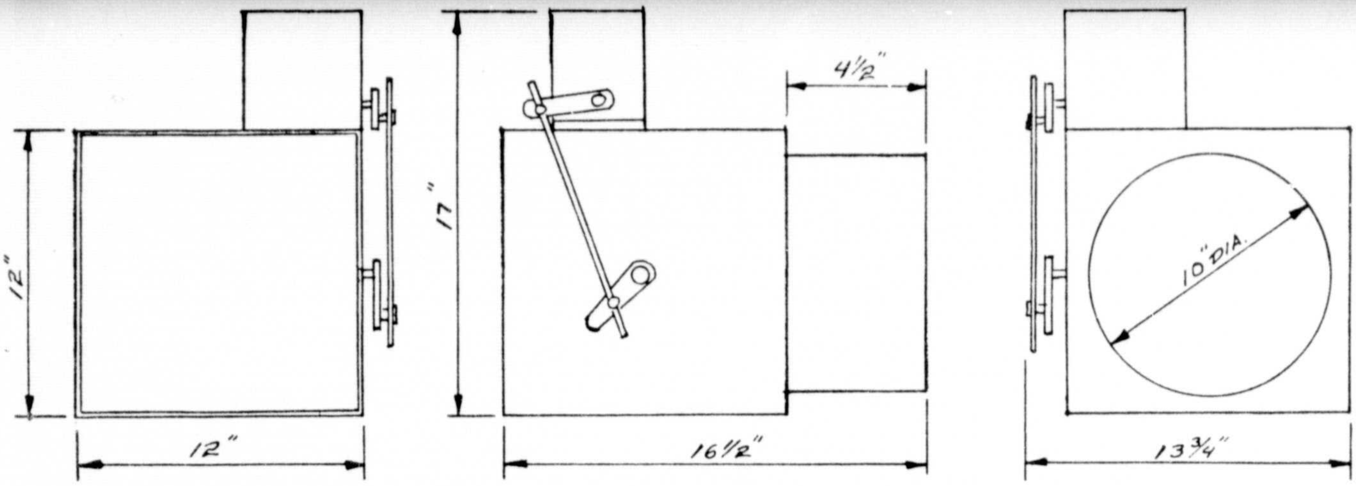
CONTEMPORARY SYSTEMS, INC.

FSV-1



THE CONTEMPORARY SYSTEMS LOW LEAKAGE FAIL-SAFE VENT VALVE, FSV-1,IS DESIGNED TO PROVIDE POSITIVE AIR VENTING FOR AIR COLLECTORS IN THE EVENT OF OVER TEMPERATURE CONDITIONS OR POWER FAILURE. THE VALVES ALLOW AMBIENT AIR TO THERMOSIPHON THROUGH THE COLLECTORS WITHOUT THE NEED FOR POWER VENTING.

QUALITY SOLAR COMPONENTS

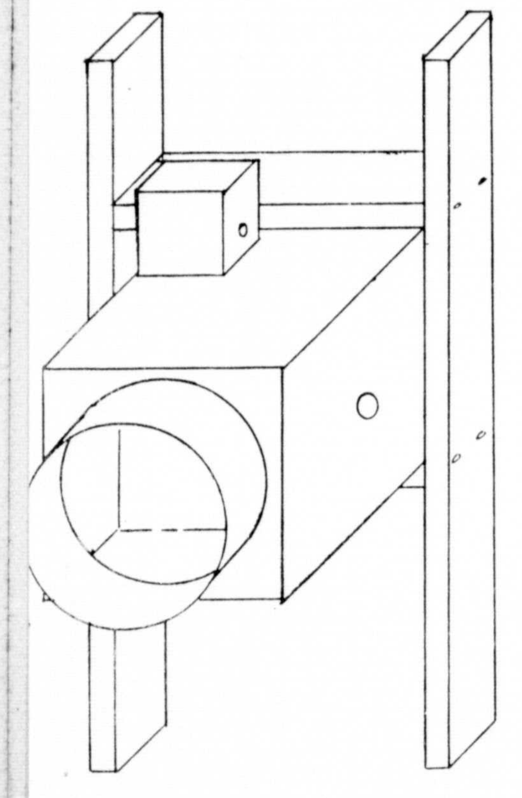


12"x12" output to be fitted with screened louver.

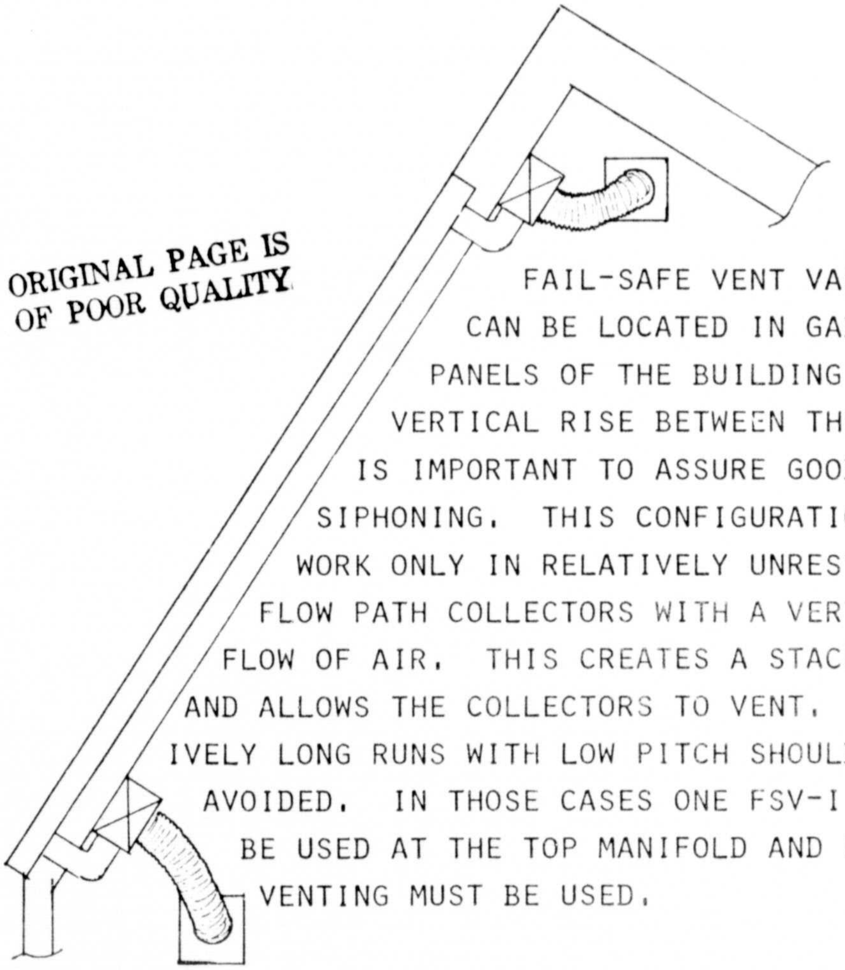
side view

10" dia. input for flexible duct coupling.

FSV-I FAIL-SAFE THERMAL VENT CONFIGURATION



FSV-I FRAMED INTO GABLE END PANEL



FAIL-SAFE VENT VALVES CAN BE LOCATED IN GABLE END PANELS OF THE BUILDING. THE VERTICAL RISE BETWEEN THE VENTS IS IMPORTANT TO ASSURE GOOD THERMAL SIPHONING. THIS CONFIGURATION WILL WORK ONLY IN RELATIVELY UNRESTRICTED FLOW PATH COLLECTORS WITH A VERTICAL FLOW OF AIR. THIS CREATES A STACK EFFECT AND ALLOWS THE COLLECTORS TO VENT. EXCESSIVELY LONG RUNS WITH LOW PITCH SHOULD BE AVOIDED. IN THOSE CASES ONE FSV-I SHOULD BE USED AT THE TOP MANIFOLD AND POWER VENTING MUST BE USED.

PRICE: 115 DOLLARS • FOB JAFFREY, N.H.

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